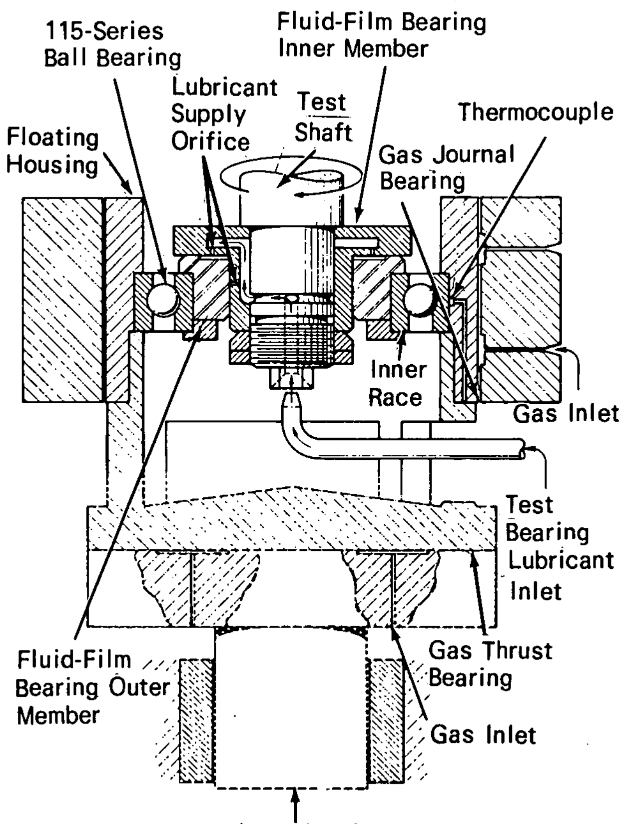
NASA TECH BRIEF

Lewis Research Center

Series-Hybrid Bearing: An Approach to Extending Bearing Fatigue Life at High Speeds

A new high-speed hybrid bearing, consisting of a fluid film bearing coupled in series with a ball bearing (see fig.), reduces the DN value (D = bearing bore number in mm; N = shaft speed in rpm)



by approximately one-third. As a result, the fatigue life of a ball bearing in a 3 million DN application, for example, could be increased as much as eight times.

Recent developments in gas turbine engines have resulted in requirements for larger shaft diameters and higher main shaft bearing speeds. Future turbine engine requirements may include bearing DN values as high as 4 million. When ball bearings are operated at DN values above 2 million, centrifugal forces produced by the balls can be significant. The resulting increase in Hertz stresses at the outer-race ball contacts may seriously shorten bearing fatigue life. The hybrid bearing alleviates this condition.

The fluid film bearing of the hybrid device consists of an orifice-compensated annular thrust bearing and a self-acting journal bearing. In the series-hybrid bearing, both the ball bearing and the annular thrust bearing carry the full system thrust load, but the two bearings share the speed.

As the hybrid system starts up, the ball bearing is operating at full speed and the fluid film bearing parts are running together. The ball bearing outer race is mounted in a stationary housing. The fluid film bearing outer member and the ball bearing inner race rotate as a unit and at such speed that the torques of the fluid film bearing and the ball bearing are equal. The centrifugal force on the oil in the rotating shaft generates hydraulic pressure to supply the pressurized thrust bearing. As soon as enough hydraulic pressure is generated to lift the applied thrust load, floating and sliding begins within the fluid film bearing. Rotational speed increases until the torque required equals the torque of the ball bearing. Thus, one element of the fluid film bearing rotates at shaft speed and the second element rotates with the inner race of the ball bearing, at a speed less than shaft speed. In this manner, speed is shared between the ball bearing and the fluid film bearing.

(continued overleaf)

Notes:

1. Operation of the system should be very stable since the fluid film bearing torque is a linear function of its sliding speed, while the ball bearing torque changes little with speed.
2. The system is automatically fail-safe. Should the fluid film bearing seize, the ball bearing will merely take over and run at full speed.
3. The following documentation may be obtained from:

   National Technical Information Service
   Springfield, Virginia 22151
   Single document price $3.00
   (or microfiche $0.95)

   Reference:
   NASA-TN-D-7011 (N71-13071), Experimental Evaluation of the Series-Hybrid Rolling-Element Bearing
4. Technical questions may be directed to:

   Technology Utilization Officer
   Lewis Research Center
   21000 Brookpark Road
   Cleveland, Ohio 44135
   Reference: B71-10173

Patent status:

This invention is owned by NASA, and a patent application has been filed. Royalty-free, nonexclusive licenses for its commercial use will be granted by NASA. Inquiries concerning license rights should be made to:

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